CLAIMS

What is claimed is:

1   1. A multicarrier transmitter comprising:

2   a precoder to encode a plurality of symbol vectors by multiplying each of the

3 symbol vectors by a complex field matrix to generate precoded symbol vectors;

4   a partitioner to group the precoded symbol vectors into a plurality of groups,

5 each group having more than one of the precoded symbol vectors; and

6   a space-frequency symbol mapper to map precoded symbols of the precoded

7 symbol vectors to one of a plurality of subcarriers of a multicarrier communication

8 channel and to one of a plurality of spatial channels at least in part based on the

9 precoded symbol's group and the precoded symbol's position within the group.

1   2. The transmitter of claim 1 further comprising:

2   a symbol mapper to generate a serial symbol stream from an input serial bit

3 stream; and

4   a serial-to-parallel converter to generate the plurality of parallel symbol

5 vectors from the serial symbol stream, each of the symbol vectors having more than

6 one symbol.

1   3. The transmitter of claim 2 further comprising inverse fast Fourier

2 transform (IFFT) circuitry to generate signals for radio-frequency (RF) transmission

3 on a corresponding one of the spatial channels from space-frequency mapped

4 symbols provided by space-frequency symbol mapper.

1   4. The transmitter of claim 1 wherein the precoder is a linear-square precoder

2 to separately precode each of the plurality of parallel symbol vectors to generate a

3 plurality of parallel precoded symbol vectors.

1   5. The transmitter of claim 4 wherein the complex field matrix is a square
2   complex field matrix having substantially a row-wise Vandermonde structure.

1   6. The transmitter of claim 1 further comprising a plurality of transmit
2   antennas, each transmit antenna corresponding to one of the spatial channels.

1   7. The transmitter of claim 6 wherein the precoder encodes an $M \times G$ number
2   of parallel symbol vectors, each parallel symbol vector having $M \times K$ symbols,
3   wherein the partitioner groups the precoded symbol vectors into G groups of
4   the parallel symbol vectors, each group having M of the precoded symbol vectors,
5   wherein M, G and K are positive integers,
6   wherein $M \times K \times G$ is equal to a number of data subcarriers of the multicarrier
7   communication channel, and
8   wherein M corresponds to a number of the transmit antennas.

1   8. The transmitter of claim 7 wherein symbols of the precoded symbol
2   vectors are associated with a layer of symbols, wherein a number of layers is M for
3   each group,
4   wherein the space-frequency symbol mapper maps each precoded symbol of
5   the precoded symbol vectors to one of the subcarriers and to one of the transmit
6   antennas based on the group and the layer associated with the symbol, and
7   wherein the space-frequency symbol mapper maps $M \times K \times G$ symbols to each
8   transmit antenna and provides the mapped symbols in multiples of the $M \times K \times G$
9   symbols to IFFT circuitry associated with the transmit antennas for modulation on
10   the subcarriers.

1   9. The transmitter of claim 7 wherein the space-frequency symbol mapper
2   maps at least some symbols of the layers to the subcarriers and the transmit antennas
3   in a sequential manner based on the symbols group and position within the group.

1   10. The transmitter of claim 1 wherein the multicarrier communication

2   channel comprises the plurality of spatial channels, each spatial channel associated

3   with one of the plurality of transmit antennas,

4   wherein each spatial channel employs the same frequency subcarriers as the

5   other spatial channels,

6   wherein the transmit antennas have a spacing therebetween of at least

7   approximately a half-wavelength of a transmit frequency.

1   11. The transmitter of claim 1 wherein the multicarrier communication

2   channel comprises a plurality of symbol-modulated subcarriers, and

3   wherein each symbol-modulated subcarrier has a null at substantially a

4   center frequency of the other subcarriers to achieve substantial orthogonality

5   between the subcarriers of the multicarrier communication channel.

1   12. The transmitter of claim 1 wherein the transmitter is part of a multicarrier

2   communication station comprising the multicarrier transmitter and a multicarrier

3   receiver, wherein the multicarrier receiver comprises:

4   a demultiplexer to generate groups of symbol vectors by combining

5   corresponding subcarrier frequency components of received symbol vectors;

6   a null canceller associated with each group of symbol vectors to perform null

7   canceling on a per-subcarrier basis for symbol vectors of the associated group based

8   on a decoded symbol vector, the null canceller to generate null-cancelled symbol

9   vectors;

10   a decoder associated with each group to decode layers of symbols of the

11   associated group and multiply an output of the decoder one layer at a time by a

12   complex-field matrix to regenerate symbol vectors for the null canceller.

1   13. A multicarrier receiver comprising:

2   a demultiplexer to generate groups of symbol vectors by combining

3   corresponding subcarrier frequency components of received symbol vectors;

4   a null canceller associated with each group of symbol vectors to perform null

5   canceling on a per-subcarrier basis for symbol vectors of the associated group based

6   on a decoded symbol vector, the null canceller to generate null-cancelled symbol

7   vectors;

8   a decoder associated with each group to decode layers of symbols of the

9   associated group and multiply an output of the decoder one layer at a time by a

10   complex-field matrix to regenerate symbol vectors for the null canceller.

1   14. The receiver of claim 13 wherein the null canceller iteratively cancels

2   interference from the symbol vectors in successive layers.

1   15. The receiver of claim 13 wherein each group of symbol vectors generated

2   by the demultiplexer comprises symbol components combined from different

3   subcarriers, and

4   wherein the decoder is a sphere decoder and generates decoded quadrature

5   amplitude modulated symbol vectors for each subcarrier of the multicarrier

6   communication channel.

1   16. The receiver of claim 13 further comprising:

2   FFT circuitry to demodulate received subcarriers of the multicarrier

3   communication signal received over a plurality of receive antennas to generate the

4   received symbol vectors associated with each receive antenna, the received symbol

5   vectors comprising symbol components from a plurality of subcarriers of the

6   multicarrier communication channel;

7   a demapper to demap the decoded symbol vectors for each group to generate

8   a plurality of parallel sets of bits; and

9   a parallel to serial converter to generate a serial bit stream from the plurality

10   of parallel sets of bits.

1   17. The receiver of claim 13 wherein the receiver is part of a multicarrier

2   communication station comprising the multicarrier receiver and a multicarrier

3   transmitter, wherein the multicarrier transmitter comprises:

4   a precoder to encode a plurality of symbol vectors by multiplying each of the

5   symbol vectors by a complex field matrix to generate precoded symbol vectors;

6   a partitioner to group the precoded symbol vectors into a plurality of groups,

7   each group having more than one of the precoded symbol vectors; and

8   a space-frequency symbol mapper to map precoded symbols of the precoded

9   symbol vectors to one of a plurality of subcarriers of a multicarrier communication

10   channel and to one of a plurality of spatial channels at least in part based on the

11   precoded symbol's group and the precoded symbol's position within the group.

1   18. A communication station comprising:

2   a plurality of antennas; and

3   a multicarrier transmitter to encode symbols with space-frequency block

4   codes for transmission over a multicarrier communication channel,

5   wherein the space-frequency block codes comprise precoded symbols

6   mapped to the plurality of transmit antennas and to subcarriers of the multicarrier

7   communication channel.

1   19. The communication station of claim 18 wherein the multicarrier

2   transmitter comprises:

3   a precoder to encode a plurality of symbol vectors by multiplying each of the

4   symbol vectors by a complex field matrix to generate precoded symbol vectors;

5   a partitioner to group the precoded symbol vectors into a plurality of groups,

6   each group having more than one of the precoded symbol vectors; and

7   a space-frequency symbol mapper to map the precoded symbols of the

8   precoded symbol vectors to one of a plurality of subcarriers of the multicarrier

9   communication channel and to one of a plurality of spatial channels at least in part

10   based on the precoded symbol's group and the precoded symbol's position within

11   the group.

1   20. The communication station of claim 18 further comprising a multicarrier

2   receiver, to decode signals received over the multicarrier communication channel

3   encoded with the space-frequency block codes using an iterative nulling process to

4   successively cancel interference from layers of symbols.

1   21. The communication station of claim 20 wherein the multicarrier receiver

2   comprises:

3   a demultiplexer to generate groups of symbol vectors by combining

4   corresponding subcarrier frequency components of received symbol vectors;

5   a null canceller associated with each group of symbol vectors to perform null

6   canceling on a per-subcarrier basis for symbol vectors of the associated group based

7   on a decoded symbol vector, the null canceller to generate null-cancelled symbol

8   vectors;

9   a decoder associated with each group to decode layers of symbols of the

10   associated group and multiply an output of the decoder one layer at a time by a

11   complex-field matrix to regenerate symbol vectors for the null canceller.

1   22. A method of transmitting over a multicarrier communication channel

2   comprising:

3   encoding a plurality of symbol vectors by multiplying each of the symbol

4   vectors by a complex field matrix to generate precoded symbol vectors;

5   grouping the precoded symbol vectors into a plurality of groups, each group

6   having more than one of the precoded symbol vectors; and

7   mapping precoded symbols of the precoded symbol vectors to one of a

8   plurality of subcarriers of a multicarrier communication channel and to one of a

9   plurality of spatial channels at least in part based on the precoded symbol's group

10   and the precoded symbol's position within the group.

1   23. The method of claim 22 further comprising:

2   generating a serial symbol stream from an input serial bit stream; and

3   generating the plurality of parallel symbol vectors from the serial symbol

4   stream, each of the symbol vectors having more than one symbol.

1   24. The method of claim 23 further comprising performing inverse fast

2   Fourier transform (IFFT) to generate signals for radio-frequency (RF) transmission

3   on a corresponding one of the spatial channels from space-frequency mapped

4   symbols generated by the mapping of the precoded symbols.

1   25. The method of claim 22 wherein encoding comprises encoding the

2   symbol vectors with a linear-square precoder to separately precode each of the

3   plurality of parallel symbol vectors to generate a plurality of parallel precoded

4   symbol vectors.

1   26. The method of claim 25 wherein the complex field matrix is a square

2   complex field matrix having substantially a row-wise Vandermonde structure.

1   27. The method of claim 22 wherein the mapping comprises mapping the

2   precoded symbols of the precoded symbol vectors to one of the subcarriers of the

3   multicarrier communication channel and to one of a plurality of transmit antennas,

4   wherein each transmit antenna corresponds to one of the spatial channels.

1   28. The method of claim 27 wherein the encoding comprises encoding an

2   MxG number of parallel symbol vectors, each parallel symbol vector having MxK

3   symbols,

4   wherein the grouping comprises grouping the precoded symbol vectors into

5   G groups of the parallel symbol vectors, each group having M of the precoded

6   symbol vectors,

7   wherein M, G and K are positive integers,

8   wherein MxKxG is equal to a number of data subcarriers of the multicarrier

9   communication channel, and

10   wherein M corresponds to a number of the transmit antennas.

1   29. The method of claim 28 wherein symbols of the precoded symbol vectors

2   are associated with a layer of symbols, wherein a number of layers is M for each

3   group,

4   wherein the mapping further comprises mapping each precoded symbol of

5   the precoded symbol vectors to one of the subcarriers and to one of the transmit

6   antennas based on the group and the layer associated with the symbol, and

7   wherein the mapping further comprises mapping MxKxG symbols to each

8   transmit antenna and to provide the mapped symbols in multiples of the MxKxG

9   symbols for modulation on the subcarriers.

1   30. The method of claim 28 wherein the mapping comprises mapping at least

2   some symbols of the layers to the subcarriers and the transmit antennas in a

3   sequential manner based on the symbols group and position within the group.

1   31. The method of claim 22 wherein the multicarrier communication channel

2   comprises the plurality of spatial channels, each spatial channel associated with one

3   of the plurality of transmit antennas,

4   wherein each spatial channel employs the same frequency subcarriers as the

5   other spatial channels,

6   wherein the transmit antennas have a spacing therebetween of at least

7   approximately a half-wavelength of a transmit frequency.

1   32. The method of claim 22 wherein the multicarrier communication channel

2   comprises a plurality of symbol-modulated subcarriers, and

3   wherein each symbol-modulated subcarrier has a null at substantially a

4   center frequency of the other subcarriers to achieve substantial orthogonality

5   between the subcarriers of the multicarrier communication channel.

1   33. A method of receiving over a multicarrier communication channel
2   comprising:
3   generating groups of symbol vectors by combining corresponding subcarrier
4   frequency components of received symbol vectors;
5   performing null canceling on a per-subcarrier basis for symbol vectors of an
6   associated group based on a decoded symbol vector to generate null-cancelled
7   symbol vectors; and
8   decoding layers of symbols of the associated group by multiplying a decoded
9   output one layer at a time by a complex-field matrix to regenerate symbol vectors
10   for performing the null canceling.

1   34. The method of claim 33 wherein performing null canceling comprises
2   iteratively cancelling interference from the symbol vectors in successive layers.

1   35. The method of claim 33 wherein each group of symbol vectors comprises
2   symbol components combined from different subcarriers, and
3   wherein decoding comprises spherically decoding to generate decoded
4   quadrature amplitude modulated symbol vectors for each subcarrier of the
5   multicarrier communication channel.

1   36. The method of claim 35 further comprising:
2   demodulating received subcarriers of the multicarrier communication signal
3   received over a plurality of receive antennas to generate the received symbol vectors
4   associated with each receive antenna, the received symbol vectors comprising
5   symbol components from a plurality of subcarriers of the multicarrier
6   communication channel;
7   demapping the decoded symbol vectors for each group to generate a plurality
8   of parallel sets of bits; and
9   generating a serial bit stream from the plurality of parallel sets of bits.

1   37. A system comprising:

2   one or more substantially omnidirectional transmit antennas;

3   a multicarrier transmitter coupled to the transmit antennas, the multicarrier

4   transmitter comprising:

5   a precoder to encode a plurality of symbol vectors by multiplying each of the

6   symbol vectors by a complex field matrix to generate precoded symbol vectors;

7   a partitioner to group the precoded symbol vectors into a plurality of groups,

8   each group having more than one of the precoded symbol vectors; and

9   a space-frequency symbol mapper to map precoded symbols of the precoded symbol

10   vectors to one of a plurality of subcarriers of a multicarrier communication channel

11   and to one of a plurality of spatial channels at least in part based on the precoded

12   symbol's group and the precoded symbol's position within the group.

1   38. The system of claim 37 wherein the transmitter further comprises:

2   a symbol mapper to generate a serial symbol stream from an input serial bit

3   stream; and

4   a serial-to-parallel converter to generate the plurality of parallel symbol

5   vectors from the serial symbol stream, each of the symbol vectors having more than

6   one symbol.

1   39. The system of claim 38 wherein the transmitter further comprises inverse

2   fast Fourier transform (IFFT) circuitry to generate signals for radio-frequency (RF)

3   transmission on a corresponding one of the spatial channels from space-frequency

4   mapped symbols provided by space-frequency symbol mapper.

1   40. A machine-readable medium that provides instructions, which when

2   executed by one or more processors, cause the processors to perform operations

3   comprising:

4   encoding a plurality of symbol vectors by multiplying each of the symbol

5   vectors by a complex field matrix to generate precoded symbol vectors;

6   grouping the precoded symbol vectors into a plurality of groups, each group

7 having more than one of the precoded symbol vectors; and

8   mapping precoded symbols of the precoded symbol vectors to one of a

9 plurality of subcarriers of a multicarrier communication channel and to one of a

10 plurality of spatial channels at least in part based on the precoded symbol's group

11 and the precoded symbol's position within the group.

1   41. The machine-readable medium of claim 40 wherein the instructions,

2 when further executed by one or more of the processors cause the processors to

3 perform operations further comprising:

4   generating a serial symbol stream from an input serial bit stream; and

5   generating the plurality of parallel symbol vectors from the serial symbol

6 stream, each of the symbol vectors having more than one symbol.

1   42. The machine-readable medium of claim 41 wherein the instructions,

2 when further executed by one or more of the processors cause the processors to

3 perform operations further comprising performing inverse fast Fourier transform

4 (IFFT) to generate signals for radio-frequency (RF) transmission on a corresponding

5 one of the spatial channels from space-frequency mapped symbols generated by the

6 mapping of the precoded symbols.